GRAPHICAL HYDRAULICS.

Water Pipe and Sewer Discharge Diagrams. By T. C. Ekin. Pp. 21. (London: Archibald Constable and Co., Ltd., 1908.) Price 12*s.* 6*d.* net.

OF all empirical formulæ devised for the solution of practical problems in natural science, hydraulic formulæ are perhaps the most involved and complex, and of all hydraulic formulæ it is doubtful whether there be a more formidable expression than the coefficient in Ganguillet and Kutter's formula for the flow of water in pipes and channels.

The general expression, and that which is now commonly recognised as furnishing the most trustworthy basis for the estimation of current velocity in such cases, is the equation devised by Chezy towards the close of the eighteenth century, viz. $V=C\sqrt{RS}$, involving the hydraulic mean depth (R) and the sine of the slope (S) in conjunction with a coefficient C.

As determined by the classical researches of Ganguillet and Kutter (the formula is more generally associated with the name of the latter only of the two eminent Swiss experimentalists), the coefficient takes the form:—

$$C=\left[\frac{a+\frac{l}{n}+\frac{m}{S}}{1+\left(a+\frac{m}{S}\right)\frac{n}{\sqrt{R}}}\right]$$

in which *a*, *l*, and *m* are respectively in English units, 41·660475, 1·811325, and 0·0028075, and *n* is a variable depending upon the degree of roughness of the surface.

The labour involved in working out casually, and as necessity arises, a particular value from so cumbrous an expression is sufficiently obvious, and it is not surprising that a number of attempts have been made to supply some ready solution applicable to different data by the construction of curves and graphical diagrams.

The author points out that hitherto such curves have not dealt with gradients exceeding 5 per 1000, and that steeper gradients are often required. He has, therefore, worked out a series of curves giving the discharges of pipes ranging from 3 to 48 inches in diameter, and the velocities, when running full, on gradients from 5·28 feet per mile, 1 in 1000 or 1 per 1000, up to 79·2 feet per mile, 1 in 66·6 or 15 per 1000, and embodied the results in four large diagrams in which each discharge curve is the result of twenty-two separate calculations, and each velocity curve has been calculated for each point in which it cuts the discharge curve.

These diagrams are not strictly derived from Kutter's original formula, but from Flynn's modified statement of it, with *n* and S (=0·001) taken as constant throughout the series of curves, and $\sqrt{R}$ varying with each diameter of pipe. The coefficient of roughness of surface (*n*) has been fixed at 0·013, as most applicable to practical work under ordinary conditions. There are a number of cases, however, in which pipes calculated with this value give results either too large or too small, and with the view of making the diagrams apply to several coefficients of roughness, the author has calculated a series of constants, embodied in a separate table. There are six tables in all forming an appendix, yielding detailed information respecting pipe flow and hydraulic data generally.

The compilation should prove of great utility to those engaged upon problems of water supply, sewage disposal, and practical problems of a kindred nature.

BRITISH OAK GALLS.

British Oak Galls. By E. T. Connold. Pp. xviii+169; 68 plates. (London: Adlard and Son, 1908.) Price 10*s.* 6*d.* net.

MR. E. T. CONNOLD has already given us a very valuable work on "British Vegetable Galls," but in that work, as the author states in the preface, the galls of the oak are not included, as he intended to publish a separate book dealing with them. This book has now appeared, and in every way it comes up to the standard of the larger work. A great feature of the book is the many life-like and excellently reproduced photographs of actual specimens of galls.

The oak is the abode of some five hundred different species of insects and other animals which subsist mainly on the leaves. Some are parasitic on the larvæ of the gall makers, and others are inquilines, which subsist on the tissues of the galls.

In his introduction the author touches upon some historical matters, and in chapter i. several very interesting and at present not fully understood phenomena in connection with the formation and colours of galls are discussed. Chapter ii., which deals with the characteristics of oak-gall growth, such as position, duration of growth, variations in shape, size and colour, &c., is also a very interesting chapter to the student of oak galls.

Chapters iii. and iv. deal respectively with the numerical aspect of oak galls and the Cynipidæ affecting the oak. The latter chapter is intended to present in a concise form such information as may be necessary for the collector or student who may not have ready access to other books which deal with these interesting and remarkable insects.

Chapter v. gives a short description of the genus Quercus, and especially of the British oak. In chapter vi. many useful hints on the collecting and mounting of oak galls are given. The rest of the book deals individually with the various species which cause oak galls. A synoptical table is given, also a table of the months in which the galls illustrated in the book may be found. A list of mid-European oak galls, with brief characteristics and position the gall occupies on the tree, is added, and will prove a great help to many. A useful index is also included.

This volume, the author tells us, is the outcome of fifteen years' study and practical research in the field. He is glad to say that he has been able to describe several galls not mentioned in any other English publication. Still, in spite of this great amount of time and study, the author does not claim completeness for his work. In the preface he says:—

"There is much more to be ascertained concerning the growth of oak galls, and one purpose of the

following pages will have been accomplished if they are the means of inspiring somebody to further unfold the subject."

The volume is certainly a very welcome addition to the literature, and can be warmly recommended to those interested in insect life, as well as to proprietors, foresters and all others interested in the growth of the British oak.

PRACTICAL ASTRONOMY.

Cours d'Astronomie. By H. Andoyer. Second part. Astronomie Pratique. Pp. 304. (Paris: A. Herman and Sons, 1909.) Price 10 francs.

TO provide anything like a complete account of the methods of instrumental astronomy, whilst keeping the work within limits suitable for a course of university lectures, is not a practicable task. The second part of Prof. Andoyer's "Cours d'Astronomie" is much more bulky than the first part (which was devoted to theoretical astronomy), yet there is everywhere evidence that the author has been harassed by want of space, and is obliged to omit details which are often of the highest practical importance. He himself is keenly sensible of this limitation; again and again throughout the work he repeats that his treatment must be confined to a general indication of the methods, without entering into details.

The point of view of the work is thus necessarily academic, and differs somewhat from that of the practical observer; nevertheless, in the descriptions of instruments and accessories much interesting practical detail is given, which is not usually found in astronomical text-books. It is clear that great care has been taken that all such information should be trustworthy; in fact, the precision and accuracy which distinguished the first part of the course are again noticeable in this part. We may, however, point out one or two questionable passages; it is stated that the chronographic method is only used for meridian observations made at observatories (p. 63). It is difficult to understand why the author should have supposed that the method is thus limited; it is not so in practice. Again, we read that in determining differences of longitude of the great observatories, in spite of all precautions, and in spite of the skill of observers, "on est loin de pouvoir répondre du dixième de seconde de temps." Prof. Andoyer must have been misled into this generalisation through some exceptional discordances in one or two of the classical determinations of longitude. In recent determinations a much greater accuracy is normally attained.

The first part of the book deals with such subjects as interpolation, the theory of errors, and the method of least squares. Common accessory apparatus, including the graduated circle, micrometer and spirit-level, is next thoroughly discussed. Three instruments are selected for specially detailed treatment; these are the theodolite, the equatorial, and the transit circle. The theodolite is probably chosen because it is likely to be more familiar to the student than a more strictly *astronomical* instrument. It is doubtful, however, whether the theodolite serves as a good introduction to instrumental astronomy or well exemplifies its principles; and the same may be said of the equatorial when used for making absolute (as opposed to differential) measures. The fundamental principles of practical astronomy are not to be found in the development of the formulæ for a general type of instrument; its main problem is the design and use of specialised instruments, in which the mechanical errors are few, and can be as far as possible determined and eliminated. We feel that the treatment of the transit circle has suffered somewhat from the devotion of so much space and the priority accorded to the theodolite and equatorial, though it must be admitted that in his account of it the author has compressed a wonderful amount of matter into a concise form. Besides the three chief instruments, numerous others are briefly described; these include the zenith telescope, coudé equatorial, heliometer, siderostat, and cœlostat.

In most cases this short treatment appears to be sufficient (though we doubt if any reader will be able to picture to himself the coudé equatorial from the description given); but when the whole subject of astrophotography is likewise dismissed in half a page, some protest seems to be required. Surely this branch of astronomy has now attained a development and importance sufficient to secure for it a place in the text-books. It cannot be urged that the subject is unsuitable for inclusion in the university course; the theory of transformation of coordinates and the formulæ involved should surely appeal more to the mathematical student than the study of the small errors of a transit instrument.

Among the other subjects considered may be noticed an excellent chapter on the fundamental constants of astronomy. Although limitations of space preclude a detailed discussion of the methods of avoiding error, a very fair idea is given of the difficulties and uncertainties involved in the determinations. We are glad to see that in a complementary chapter an explanation of Gauss's method of determining an orbit from three observations has been included in the course.

A. S. E.

OUR BOOK SHELF.

Water Hammer in Hydraulic Pipe Lines. By A. H. Gibson. Pp. iv+60. (London: A. Constable and Co., Ltd., 1908.) Price 5*s.* net.

THE phenomenon of water hammer in pipe mains is one familiar to all who have had any practical experience in matters of water supply, either for domestic consumption or for power purposes. Indeed, it is safe to say that it comes within the observation of most people. There can scarcely be a householder who is not aware that the abrupt closing of a tap, or valve, produces a violent and perfectly audible concussion in a water pipe, though perhaps he may not realise that the shock, if repeated with sufficient frequency, is capable, in process of time, of producing rupture, unless the pipe possess a very large margin of strength to resist so considerable an excess over the normal pressure, or unless a relief valve be provided. This latter expedient is most generally adopted in all important installations, where the consequences of a sudden outburst would be serious, if not disastrous.

In the case of a phenomenon of such common occurrence, it is somewhat remarkable that there is